CSCI 101 Connecting with Computer Science Lecture 4: Applications of CS III



Jetic Gū 2020 Fall Semester (S3)



Overview

- Focus: Computing Science in Production
- Architecture: von Neumann
- Readings: 6, 7
- Core Ideas:
 - 1. Modern Robotics
 - 2. Challenges in Robotics

The Digital Revolution

P0 Review











P0 Review



Patient Oriented

- Digitisation of Patient Records database optimisation
- Computer analysis of Individual Examination Reports





Universities and Labs Knowledge Oriented

- Quantitative Analysis
 including HGP
- Study biology, develop new treatments



P0 Review

CS in Research

- Analyse large quantities of data in short periods of time
- Discover correlations between parameters and output
- Automate experimental procedures
- Physical simulations of Models







Modern Robotics

and why it matters



Robotics Important Aspects of Robotics

- A machine programmable by a computer, capable of carrying out a complex series of actions automatically.
 - What kind of feedbacks (audio/visual/motor) can the robot provide? (Behaviour)
 - How much input does it expect the human to provide?
 - What kind of sensor does the robot have?





Robotics Robot: Vacuum Cleaning Robot

- Feedbacks Motor (for movement), Vacuum/Sweeper controls
- Human Input Schedule
- Sensors Obstacle/Collision sensors, Optical Infrared camera





Robotics Robot: Assembling Robot

- Task
 Motor rotations
- Human Input Complete assembling programmes
- Sensors
 Pressure sensors or none





Robotics Robot: Research/Rescue Robot

- Task
 Motor rotations
- Human Input Remote controls
- SensorsVarious





Robotics Robot: Autonomous Vehicles

- Task Motor rotations
- Human Input Destination
- Sensors Optical sensors, Infrared sensors, Lidar sensor array, 5G antenna, etc.





Robotics Robotics Problems in CS

- Degree of automation/intelligence
 - Hardware Mechanical engineers are responsible for all the motor functions and sensor design/installation, for computing scientists, the most important problem is control
 - Software CS people handles the algorithm for controlling the machine. Even remotely controlled machines such as drones have this problem!





Remote Controlled Drones

- Sensors
 - Proximity sensors
 - Optical sensors (daylight and infrared)
 - Pressure sensors
- Software
 - Automatic obstacle detection and evasion
 - Route planning
 - etc.







Remote Controlled Drones

P1 Robotics

- Input
 - Sensors
 - Human command
- Output
 - Motor control / Resource management
 - Audio/Visual Feedback







P2 Challenges

Challenges in Robotics





Challenges in Robotics

- Hardware level
 - Power source
 - Material / Manufacturing Cost
 - Mechanics
 - Not this course's concern

- Software level
 - Environmental Mapping
 - Artificial Intelligence
 - Brain-Computer Interface(*)
 - Swarm Intelligence





P2 Challenges

Challenges in Robotics

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- How to correctly interpret sensor input and establish the surrounding environment
 - 2D still image -> 3D scene
 - 2D still images -> 3D scene(s)
 - Motion picture -> 3D scene(s)
 - Lidar input -> 3D scene



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LiDar: Laser Radar, it detects distances from objects LiDar: outputs are already 3D, all you need is object detection



P2 Challenges

- Planning: Given objective, how do we achieve it?
 - E.g. path finding, navigation system
 - Input: map, current traffic conditions (including road blocks)
 - Output: route, lane changing information (for autonomous cars), traffic signal sensing and VRU¹ detection etc.
- How to react in unseen situations?
 - All is trained on seen examples, and we assume it will generalise well in unseen
 - More in the following weeks
- 1. Vulnerable Road User

Other AI Challenges



Swarm Intelligence

- Swarm: a group of autonomous robots
 - Inspired by animals such as bees
 - Cooperation Centralised management or independent
 - Efficiency via Specialisation division of labour
 - Communication to achieve collective objectives













An In-depth Look at Real Ant Challenges Behaviour

Nest



Food



Interrupt The Flow

P2 Challenges





Obstacle



The Path Thickens!







The New Shortest Path





Obstacle



Adapting to Environment Changes

P2 Challenges





Adapting to Environment Changes

P2 Challenges





P2 Challenges Possible Solutions to Create Swarm Intelligence Systems

- Create a catalog of the collective behaviours (impossible)
- Model how social insects collectively perform tasks
 - Use this model as a basis upon which artificial variations can be developed
 - Model parameters can be tuned within a biologically relevant range or by adding non-biological factors to the model
- This is still a relatively new area of research!







P3 Questions

Questions to Think About



How will robots change the human society?

- What are the robots you've encountered?
- Are robots going to take people's job?
 A human-centered robot will not replace humans, only forms of human labor that are dangerous, repetitive, and exhausting.
- Are there problems with the 3 laws?

P3

Questions

- What do you think is the ideal place for robots in human society? ref: *I, Robot, Her*
- What do you think can swarm technology do? What are the advantages?

?

- A human-centered robot assists human beings, extends their capabilities, and promotes their quality of life.
- To protect its own existence, a humancentered robot protects the existence of its human operator.





- being to come to harm.
- orders would conflict with the First Law.
- conflict with the First or Second Laws.

• A robot may not injure a human being or, through inaction, allow a human

A robot must obey the orders given it by human beings except where such

• A robot must protect its own existence as long as such protection does not

